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All-fibered high-quality 28 GHz to 112 GHz pulse sources based on nonlinear compression of optical temporal besselons

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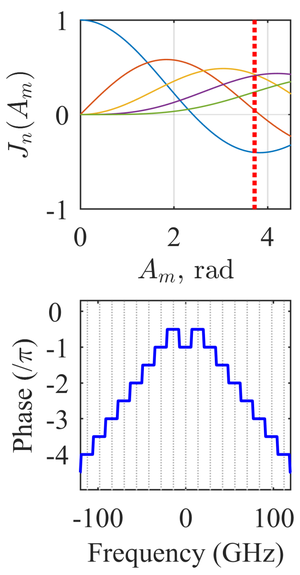
Introduction

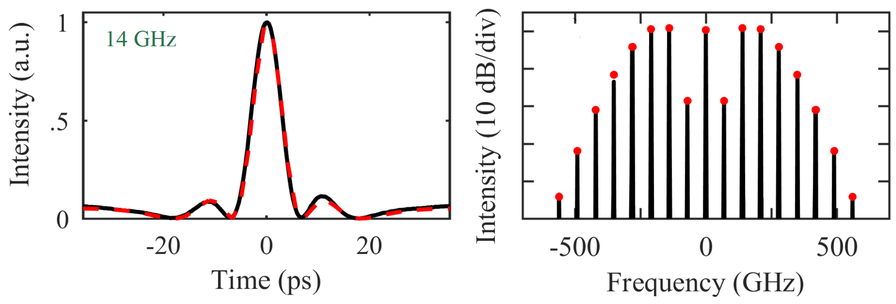
GOAL : generation of high-quality pulse trains at high repetition rates

Besselon waveform [1] :

1. CW + temporal sinusoidal phase
   $\psi(t) = \exp(iA_m \cos(\omega_m t))$
   ⇒ Jacobi-Anger expansion :
   $\psi(t) = \sum_{-\infty}^{\infty} J_n(A_m) \exp(in\omega_m t)$
   $\omega_m = 2\pi f_m$ - repetition rate
   A_m - modulation amplitude (rad)
   J_n - Bessel function of the first kind of order n
   ⇒ subsequent spectral lines have a $\pi/2$ phase shift
2. Triangular spectral phase to cancel out the phase offset [2]
   ⇒ Fourier transform limited waveform
   ⇒ high extinction ratio
   ⇒ full theoretical description available

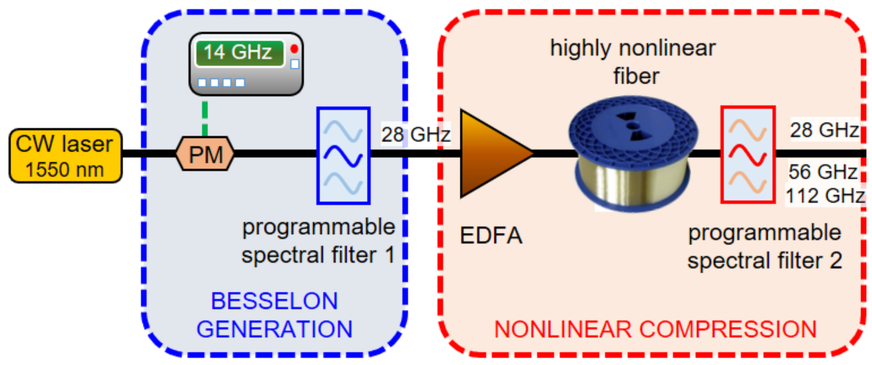


Besselon waveform generated at 14 GHz and $A_m = 3.72$ rad
(FWHM = 7.2 ps, duty cycle = 0.2)



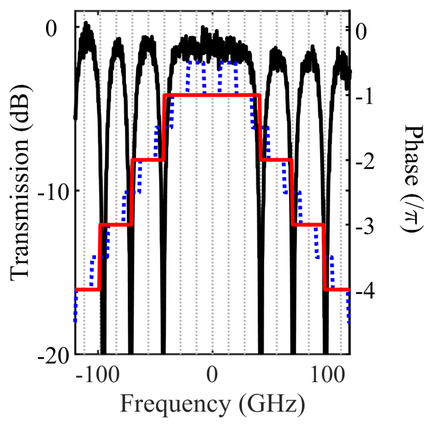
red - theory, black - experiment

Experimental setup



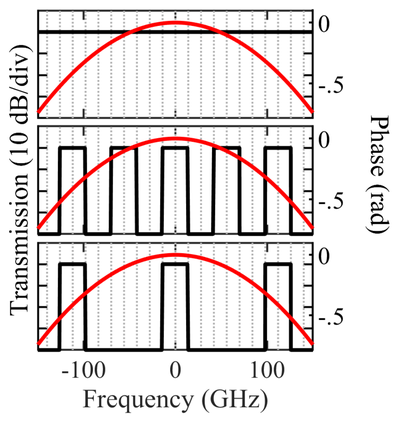
WaveShaper 1

- Only phase profiles for 14 GHz (blue) or for 28 GHz (red)
  black - ASE signal



WaveShaper 2

- Quadratic spectral phase for chirp compensation (red)
- Filters used for multiplexing (black)



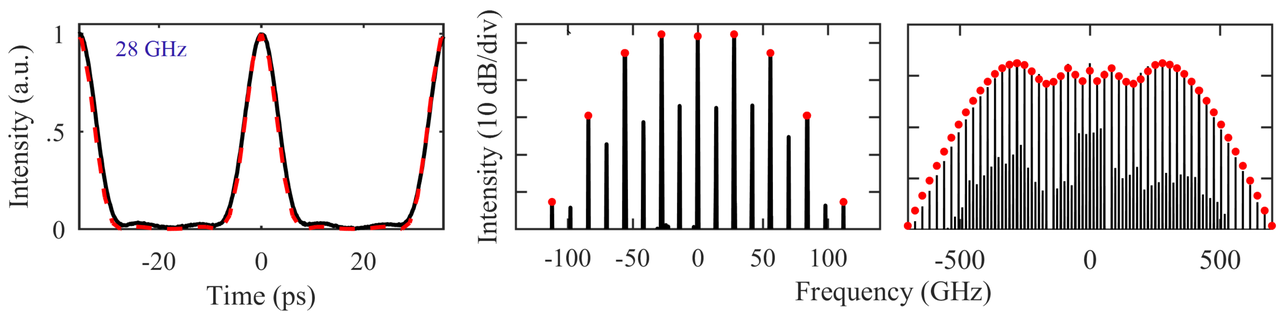
HNLF : $L = 1$ km, $\gamma = 10$ /W/km , $\beta_2 = 0.89$ ps^2/km , $\alpha = 0.5$ dB/km

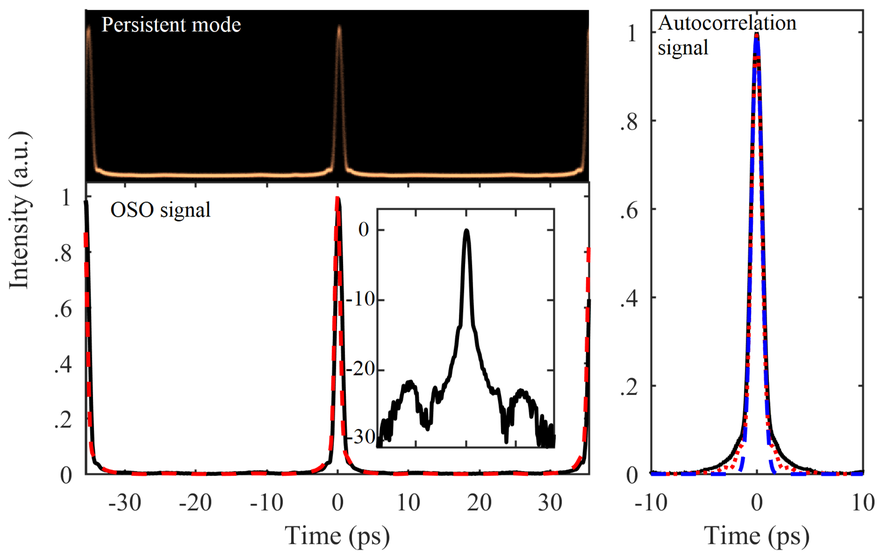
Results at 28 GHz,56 GHz and 112 GHz

1. Phase-notch filter to multiplex the repetition rate before the nonlinear stage [3]

Waveform at 28 GHz
(FWHM = 7.2 ps , duty cycle = 0.2)

Spectrum after NL propagation
(extended over 1.4 THz)



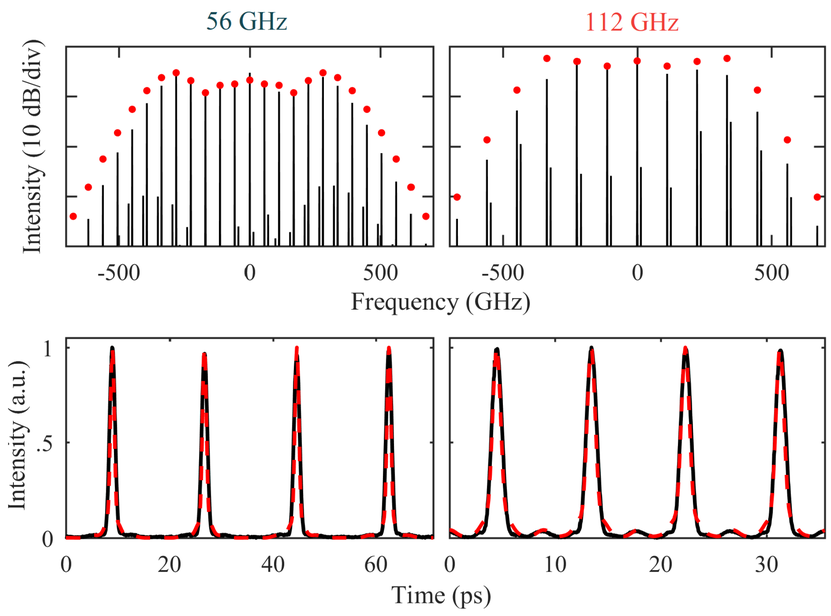


After the chirp compensation :

- high ER (more than 20 dB)
- high stability
- low duration (OSO and autocorrelation signal)

red - NLSE simulation, black - experiment,blue - autocorrelation of a Gaussian pulse

2. Attenuation of spectral lines of the NL-broadened spectrum to further multiplex

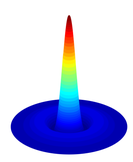


red - NLSE simulation, black - experiment

	28 GHz	56 GHz	112 GHz
FWHM, ps	0.78	0.83	0.94
Duty cycle	0.022	0.074	0.105

Conclusion

- high repetition-rate source
- simple setup (single phase modulator)
- high-quality pulse trains at 14 GHz, 28 GHz, 56 GHz and 112 GHz



References

1. A. Sheveleva, U. Andral, B. Kibler, S. Boscolo, and C. Finot, "Temporal Optical Besselon Waves for High-Repetition Rate Picosecond Sources," JPhys Photonics, https://doi.org/10.1088/2515-7647/abdd1080 (2021).
2. U. Andral, J. Fatome, B. Kibler, and C. Finot, "Triangular spectral phase tailoring for the generation of high-quality picosecond pulse trains," Opt. Lett. 44, 4913 (2019).
3. A. Sheveleva and C. Finot, "Nonlinear Compression of Besselon Waves for High Repetition-Rate Subpicosecond Pulse Trains," IEEE Photon. Technol. Lett. 32, 1493 (2020).
4. T. Kobayashi, H. Yao, K. Amano, Y. Fukushima, A. Morimoto, and T. Sueta, "Optical pulse compression using high-frequency electrooptic phase modulation," IEEE J. Quantum Electron. 24, 382-387 (1988).
5. D. Marion and J. Lhermite, "Electro-optically modulated lasers: pulse energy and contrast enhancement derived from theoretical spectrum," Opt. Lett. 45, 2664–7 (2020)